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Research and Development
Project Management

Course Number 42501

Agenda

This class presents a process model for the management of research and development projects

- **Introduction**
- **WebEx Training**
- **Principal Investigator (PI) R2A2s**
- **Project Management Processes**
- **Project Management Knowledge Areas**

Key Takeaway: We'll give you an overview of the all of the tools. Use only what you need for your R&D project.

Introduction

- **Host / Instructors**

  Laurie Wong, Science Resource Office (SRO-CP), your course sponsor

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  Lead for the R&D Project Management effort, including the pilot of Question-Based Project Management and a new R&D Project Management System (PM2L)

  Dr. Bill Priedhorsky, Lab Fellow and LDRD Program Director

  505.667.5204 / wpriedhorsky@lanl.gov

  44 years at the Lab; originator the R&D project management program

  Dr. Mike Pappas, ALDCP Project Management Division Leader

  505.487.0111 / mpappas@lanl.gov

  30 years project management experience

  University of Texas lecturer on capital project management; Ph.D. in civil engineering

- **Administrator**

  Ashley D'Anna, Science Resource Office (SRO-CP

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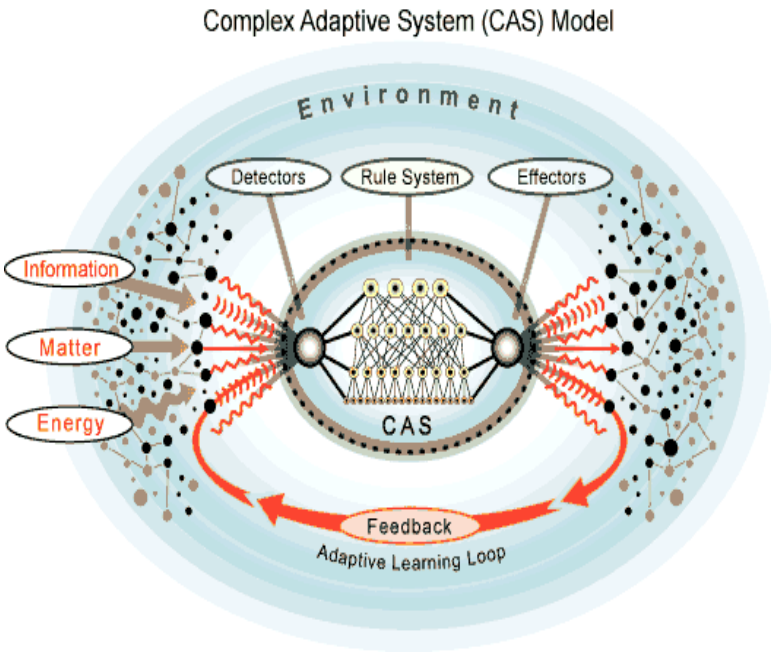
  Lead for the Collaboration Space

R&D projects: More like a complex adaptive system

- **Can have lots of moving parts all focused on navigating the unknown**
- **First of a kind; uncertain outcomes**
- **No historical basis for predicting project steps or costs**
- **The research plan may have to change mid-stream based on what is being learned; variability creates more risk**

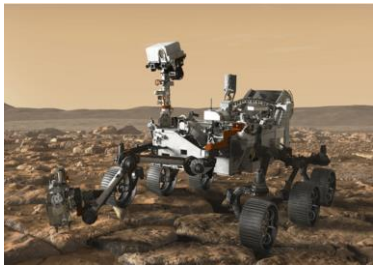


Project management gives you the situational awareness you need to be more creative and agile, and respond effectively to what can be a rapidly changing environment.

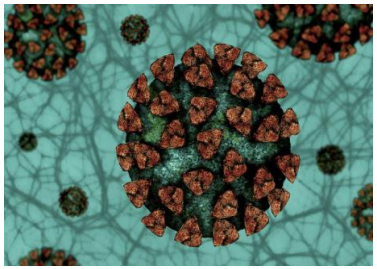
Projects are more than just another day at work

- **Projects are the primary method for making a change**
  - New scientific discoveries
  - New facilities
  - New capabilities
  - New processes
- **Projects are the life-blood for sustaining the institution**
- **Project success and failures cast a reputation over LANL for a long period of time**

You, as the principal investigator (PI), are vital to LANL's success.



Mars Rover



MEDIAN: Analyzing COVID intervention scenarios

DARHT Weather Enclosure

What is a project?

- **Characteristics of a Project**
  - Temporary – Definitive Start and Finish
  - Unique – A product, service or result not done before
  - Constrained - Scope, Schedule, Budget and Quality
- **Project Expectations**
  - Deliver within Budget
  - Deliver on time
  - Meet the agreed upon scope
  - Meet customer quality requirements
- **Triple Constraint**
  - Changes in one constraint impact the other constraints
  - Quality of work is constrained by scope, schedule and budget

For R&D projects, budget and schedule are often fixed, so the scope has to be more dynamic

The PI leads and manages the project to successful completion.

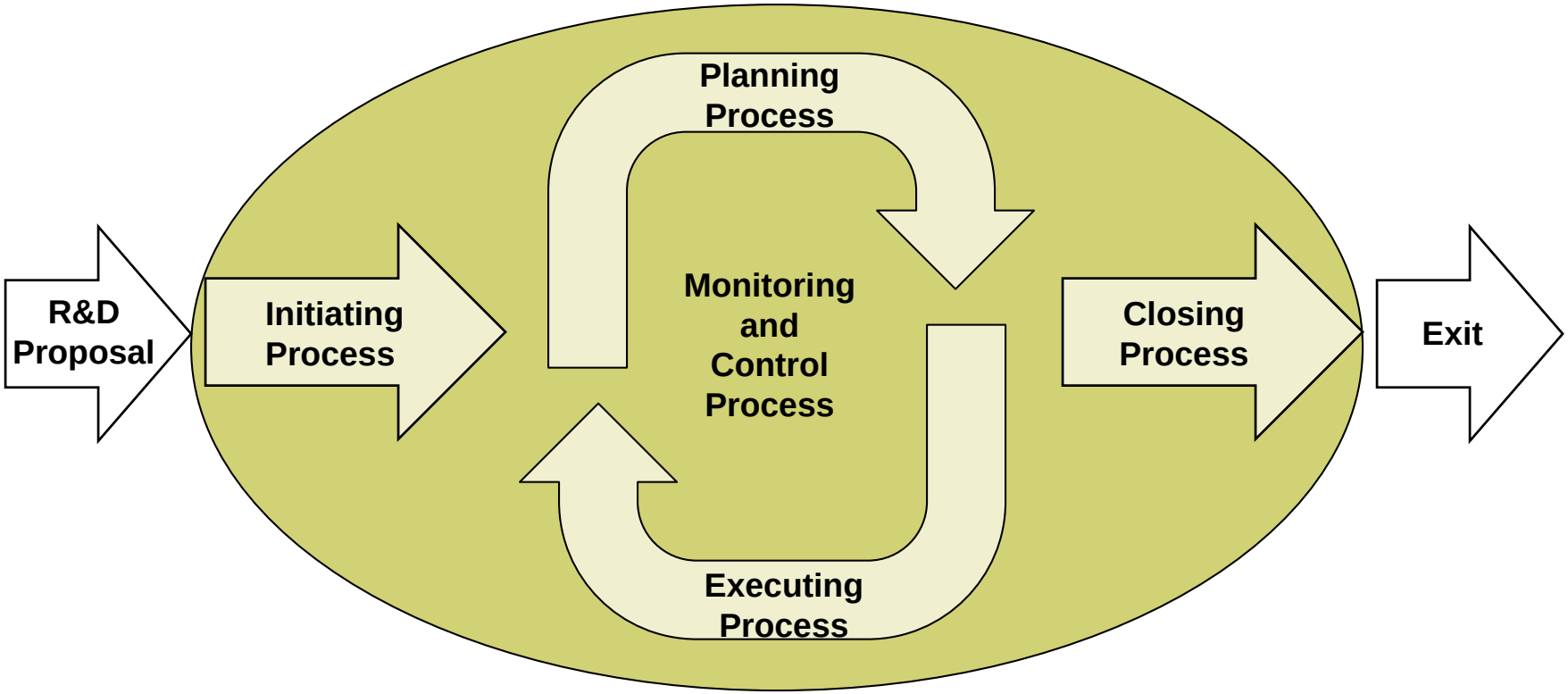
- **Responsibilities:**
  - Define the requirements of the project
  - Plan the work activities
  - Identify the necessary team member skills and work with line management to identify staff
  - Balance the collaboration/decision-making style with the needs of the project and the team members (e.g., consultative, directive) *
  - Lead the project's execution
  - Analyze and manage project risks, trends, and changes
  - Serve as the focal point for both internal and external communication on the project, ensuring that one consistent message is being communicated to the sponsor and outside world

* Jeanne Fair, A proposer's guide to the "Science of Teaming," presented Dec 8, 2021 at "Getting and Staying Competitive in LDRD" event

The PI leads and manages the project to successful completion. (continued)

- **Responsibilities (cont'd)**
  - Provide routine status reports to LANL management
  - Safely, securely, and compliantly close out the project
  - Identify opportunities for future work capture
- **Authorities:**
  - Approve the project plan (including cost estimate) and any changes
  - Expend project funds consistent with Laboratory policy
  - Require accountability from project team members
  - Provide input to line management on the level of performance of line's staff while completing project tasks
  - Approve the assignment and re-assignment of key project team members
- **Accountability:** To the program manager and line management (and Sponsor) for fulfilling the responsibilities and authorities listed above

Project management process



The selection of your R&D proposal approves funding and authorizes you to **initiate** the project, i.e., to plan how you will get the project done.

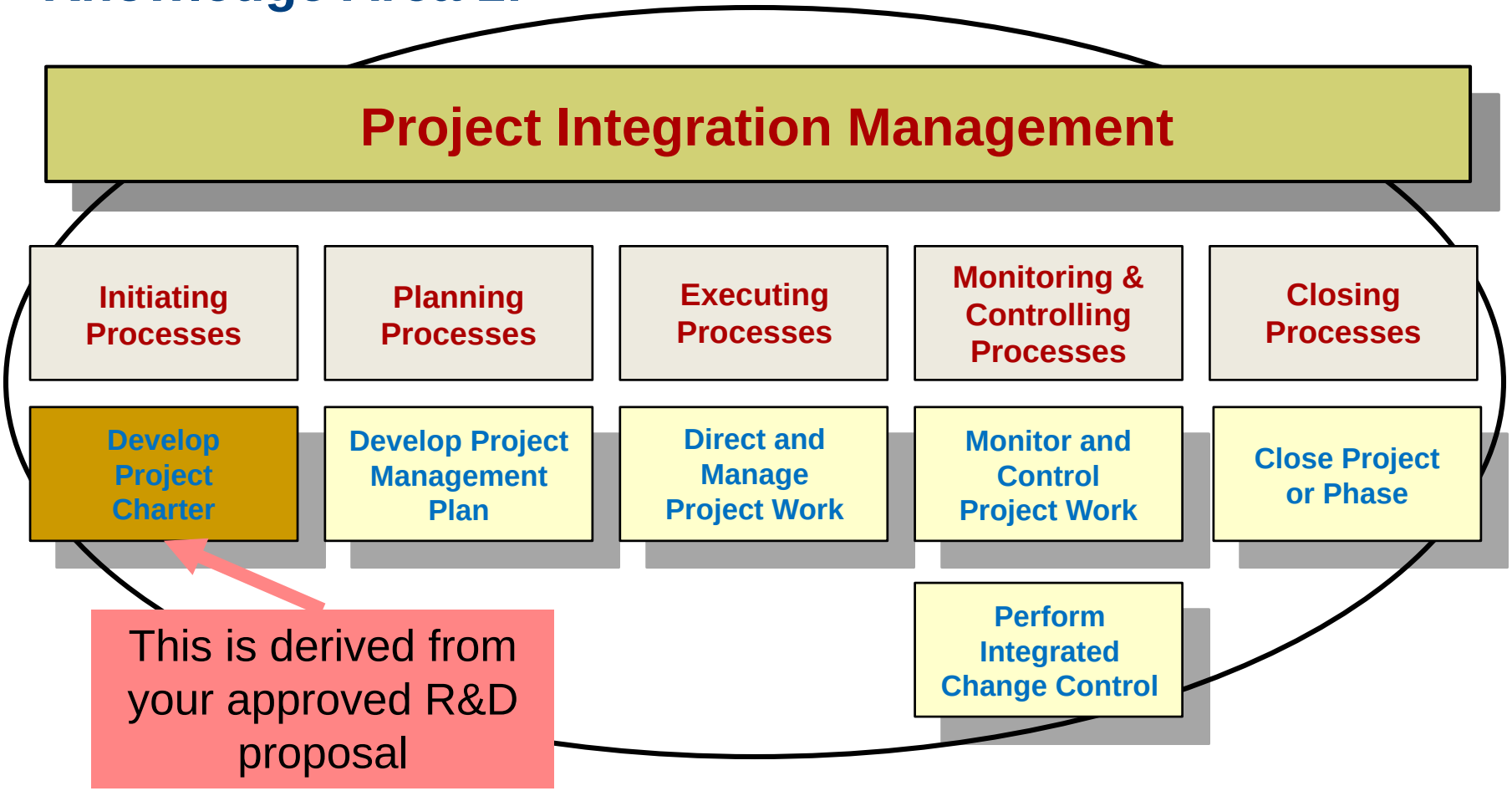
10 knowledge areas support the 5 process groups

Knowledge Areas / Processes	Integration	Scope	Time	Cost	Quality	Human Resource	Communication	Risk	Procurement	Stakeholder Management
Initiating Process	✓									✓
Planning Process	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Executing Process	✓				✓	✓	✓		✓	✓
Monitoring and Control	✓	✓	✓	✓	✓		✓	✓	✓	✓
Closing Process	✓								✓	

Most involved processes and knowledge area

Knowledge Areas / Processes	Integration	Scope	Time	Cost	Quality	Human Resource	Communication	Risk	Procurement	Stakeholder Management
Initiating Process	✓									✓
Planning Process	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Executing Process	✓				✓	✓	✓		✓	✓
Monitoring and Control	✓	✓	✓	✓	✓		✓	✓	✓	✓
Closing Process	✓								✓	

Knowledge Area 1:



Project Integration happens throughout the life of the project and is in place to keep everyone focused on the same end point

Successful project integration: What does it look like?

- **Each team member can explain why the project exists and what it consists of at both the large and small scale**
- **Interdisciplinary teams see the importance of their individual contributions to the larger effort**
- **Team members communicate frequently and effectively with key points of interface so the entire team can navigate a rapidly changing environment**
- **Conflicts are identified before they occur so they can be managed to the benefit of the project.**
- **Team members have a high level of trust in each other. ***

* Jeanne Fair, A proposer's guide to the "Science of Teaming," presented Dec 8, 2021 at "Getting and Staying Competitive in LDRD" event

Project integration: Synergy makes ground-breaking work possible.

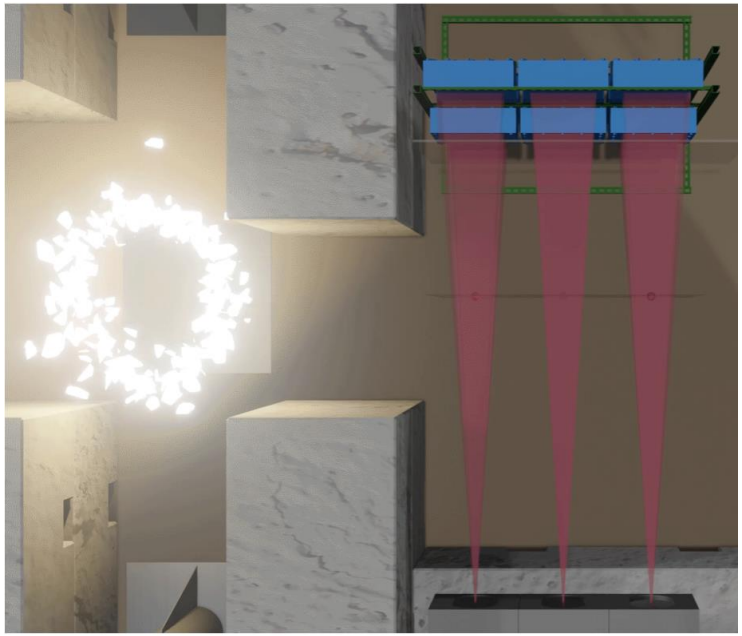
"[T]he ability to combine ideas and capabilities in a unique and creative way is what makes the work at LANL special, with especially effective outcomes.

… It's the synergy between such highly specialized and accomplished scientists and engineers that makes this ground-breaking work possible."

[Emphasis added.]

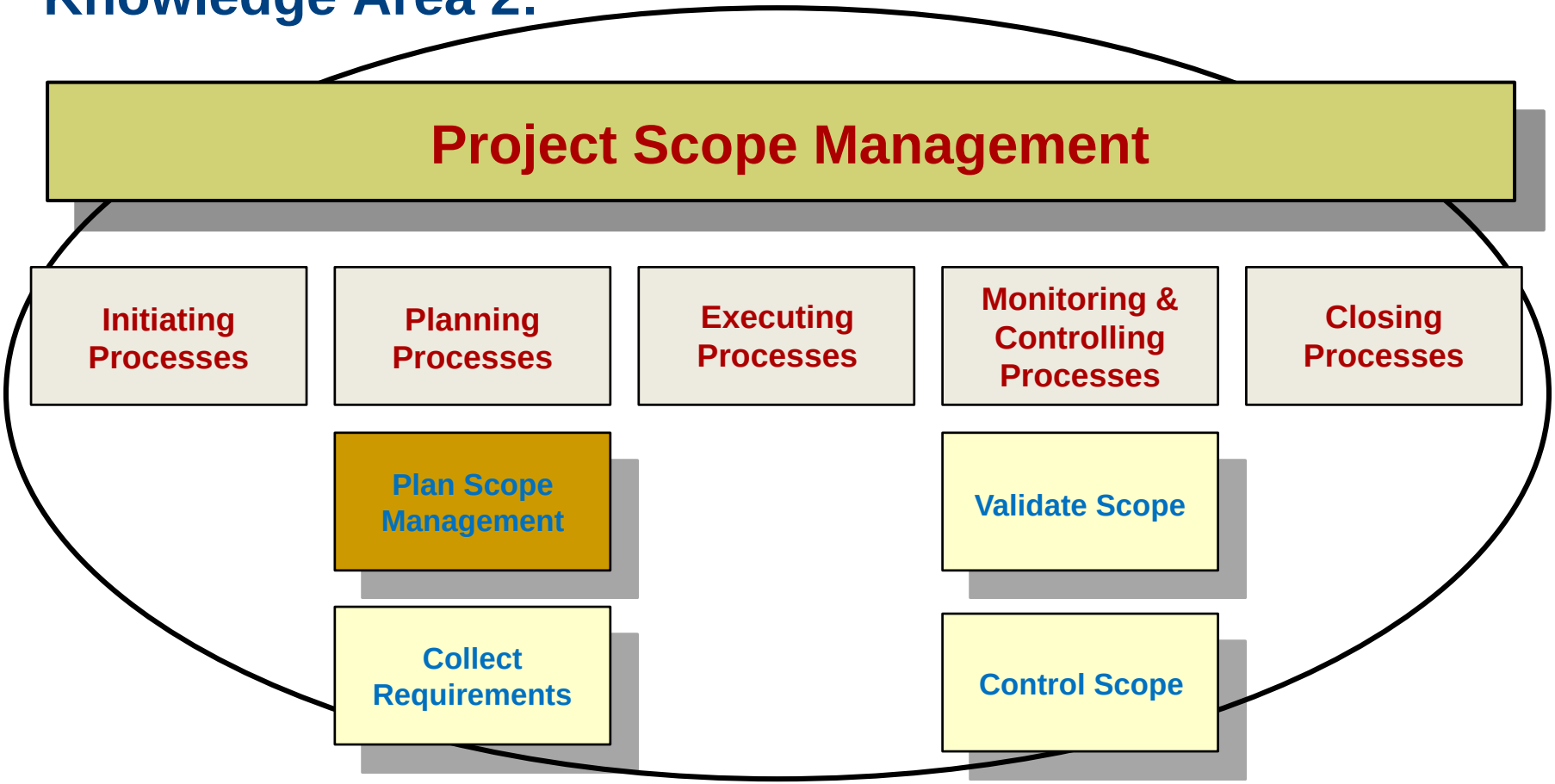
Andres Cortez, W-1 group leader

(LANL Today, Dec 13, 2021, *Fragments fly with high data capture*)



In a series of experiments on a (non-nuclear) explosives package of a B61 warhead … Lab engineers and scientists [used x-rays in a unique way] to capture high-level data on a fragment field with greater detail than ever before.

Knowledge Area 2:



Project Scope Management creates a clear vision of what the project is to create that all parties agree upon, and ensures delivery of that item.

Question-based project management (QBPM)

"To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science."
Albert Einstein

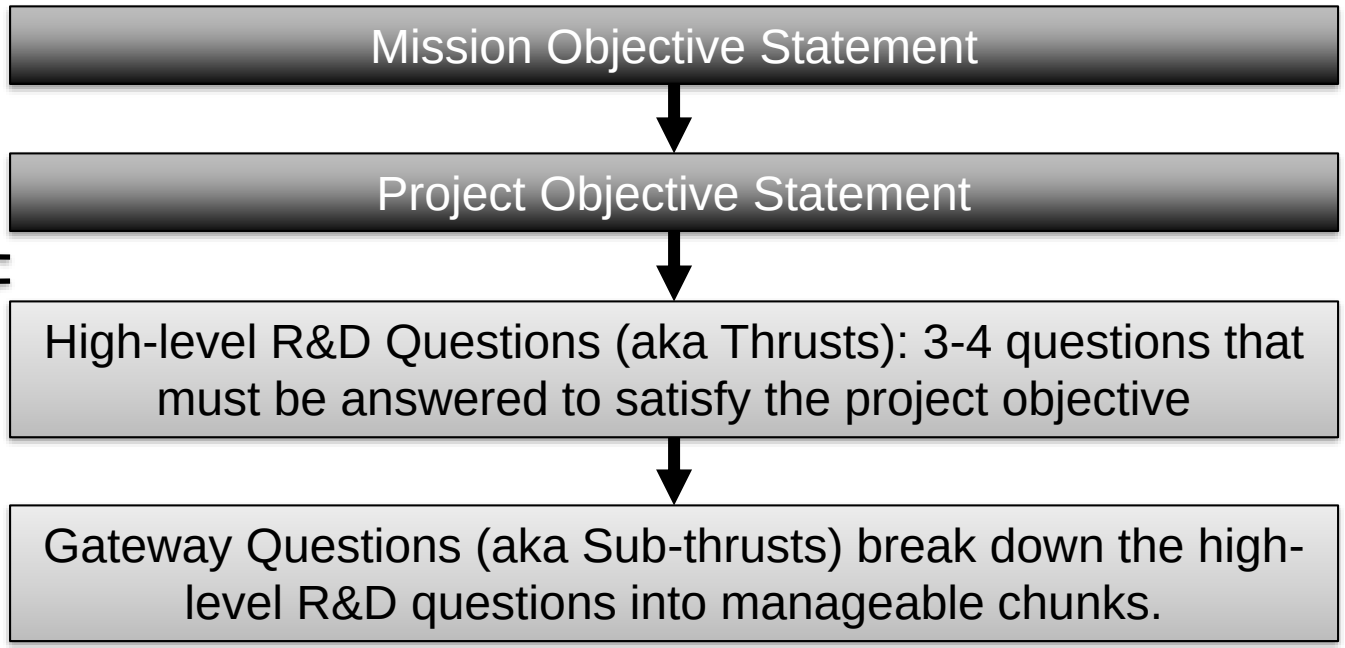
- **Structures the project scope around R&D questions**
- **Enables the creativity essential to research by focusing the team on (1) how and why the work matters, and (2) asking the right questions**
- **Promotes flexibility – research direction can change to investigate new findings, while the questions remain the same**
- **Keeps the team thinking instead of just performing tasks**

The LDRD project team that developed and tested QBPM won a 2019 R&D 100 Award and the Gold Medal in the Market Disruptor-Products Special Recognition Category for game-changing products.

QBPM hierarchy

How/why it matters

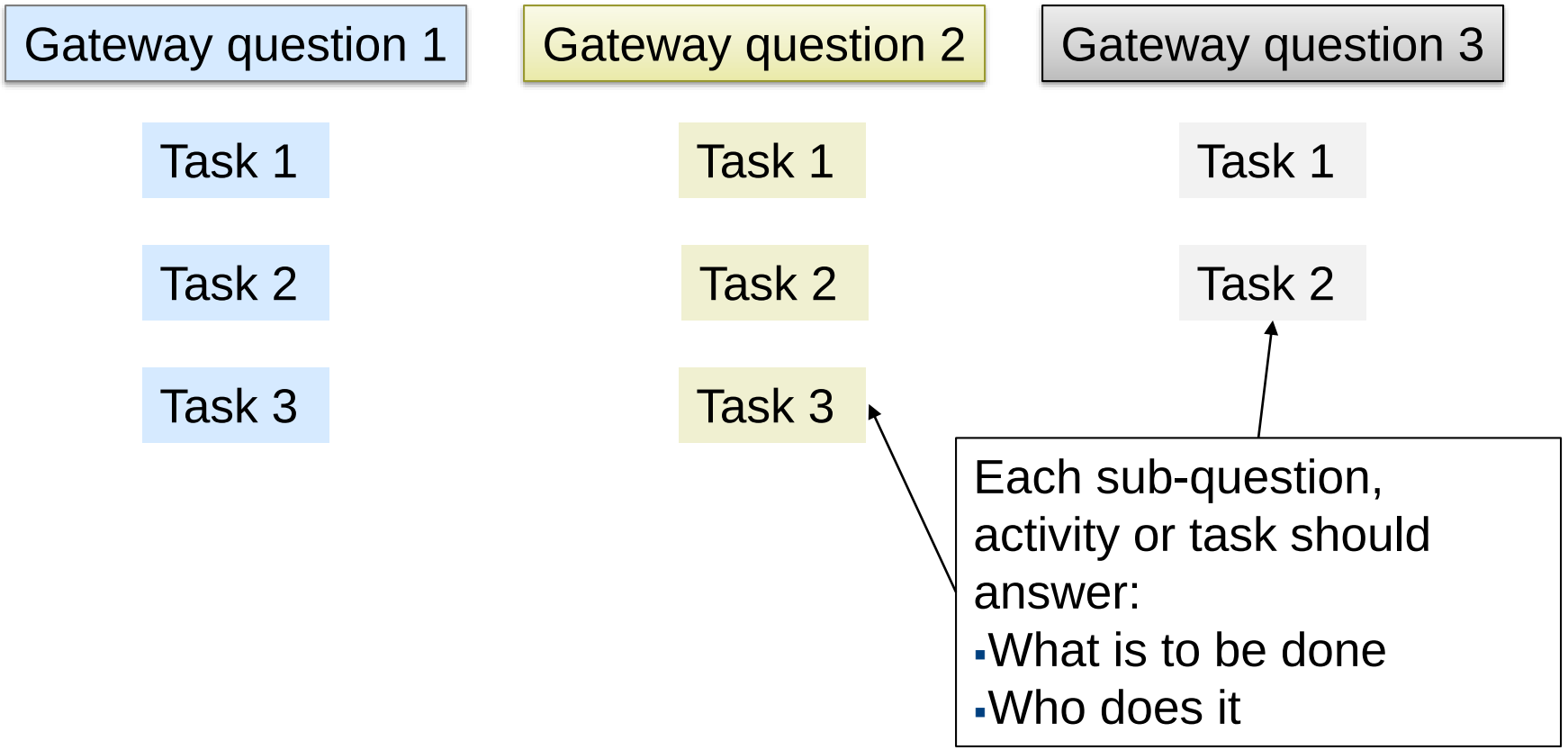
Asking the right questions



To develop your questions, think ”publication title” or “conference talk” – ask broad questions that could lead to novel insights, breakthroughs

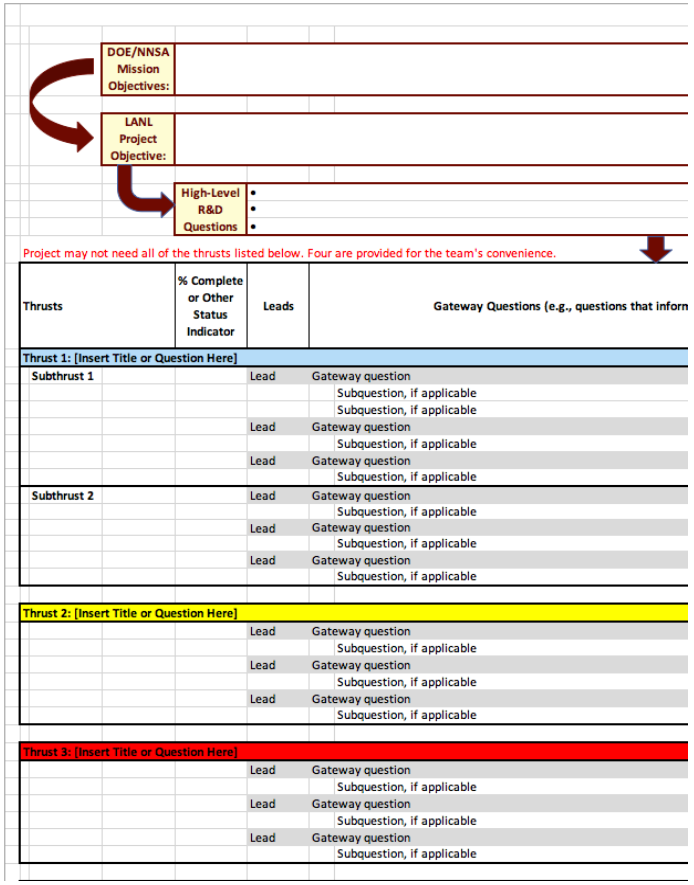
- “How do the dominant conditions affect …
- “What are the optimal properties or characteristics for …”
- “What are the relative advantages, trade-offs between …”

QBPM hierarchy: Identify the necessary sub-questions, activities, or tasks needed to answer each question



Simple project planning checklist

- **Excel Spreadsheet**
- **Designed for R&D projects; QBPM**
- **Can be used to align stakeholders and the project team**
- **Easily completed and can be updated to reflect changes**
- **Template available on the Science Resource Office's Project Management website**
  http://int.lanl.gov/org/ddste/sro/rdprojectmgmt/index.shtml



DOE/NNSA Mission Objectives:			
LANL Project Objective:			
High-Level R&D Questions	•		
•			
•			

Project may not need all of the thrusts listed below. Four are provided for the team's convenience.

Thrusts	% Complete or Other Status Indicator	Leads	Gateway Questions (e.g., questions that inform
Thrust 1: [Insert Title or Question Here]			
Subthrust 1		Lead	Gateway question
			Subquestion, if applicable
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
Subthrust 2		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
Thrust 2: [Insert Title or Question Here]			
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
Thrust 3: [Insert Title or Question Here]			
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable

QBPM example: Objectives

DOE Mission Objective: NNSA Nuclear Nonproliferation: Develop new airborne platforms to surveil suspect sites in remote agricultural areas using a common-place resource that will blend into the environment.

LANL Project Objective: Develop a short-range aerial surveillance platform utilizing the recently discovered brain-interface research with pigs, enabling autonomous flight up to an altitude of 5,000 feet and a maximum speed of 20 mph

Go to next page

QBPM example: High-level R&D questions (aka thrusts)

Thrust 1: Flight Platform – What are the design parameters and design options for a flight platform enabling seamless interface with the pig?

Thrust 2: Autonomous Operation – What are the fundamental limits of the pig brain interface and will these accommodate the demands of long-term, but low-asset, surveillance?

Thrust 3: Operational Requirements – What will be required to operate, secure and maintain the platform, manage the data it gathers, etc.?

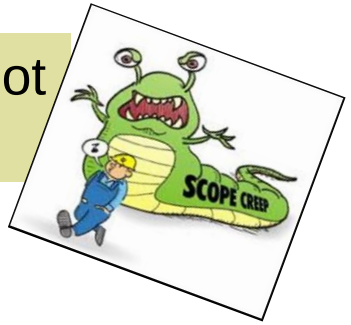
Thrust 4: Prototype Demo – To what degree does actual performance agree with predicted performance?

Breakout Session: Develop 1-2 gateway questions for one of the research objectives, and several related tasks. (10 min)

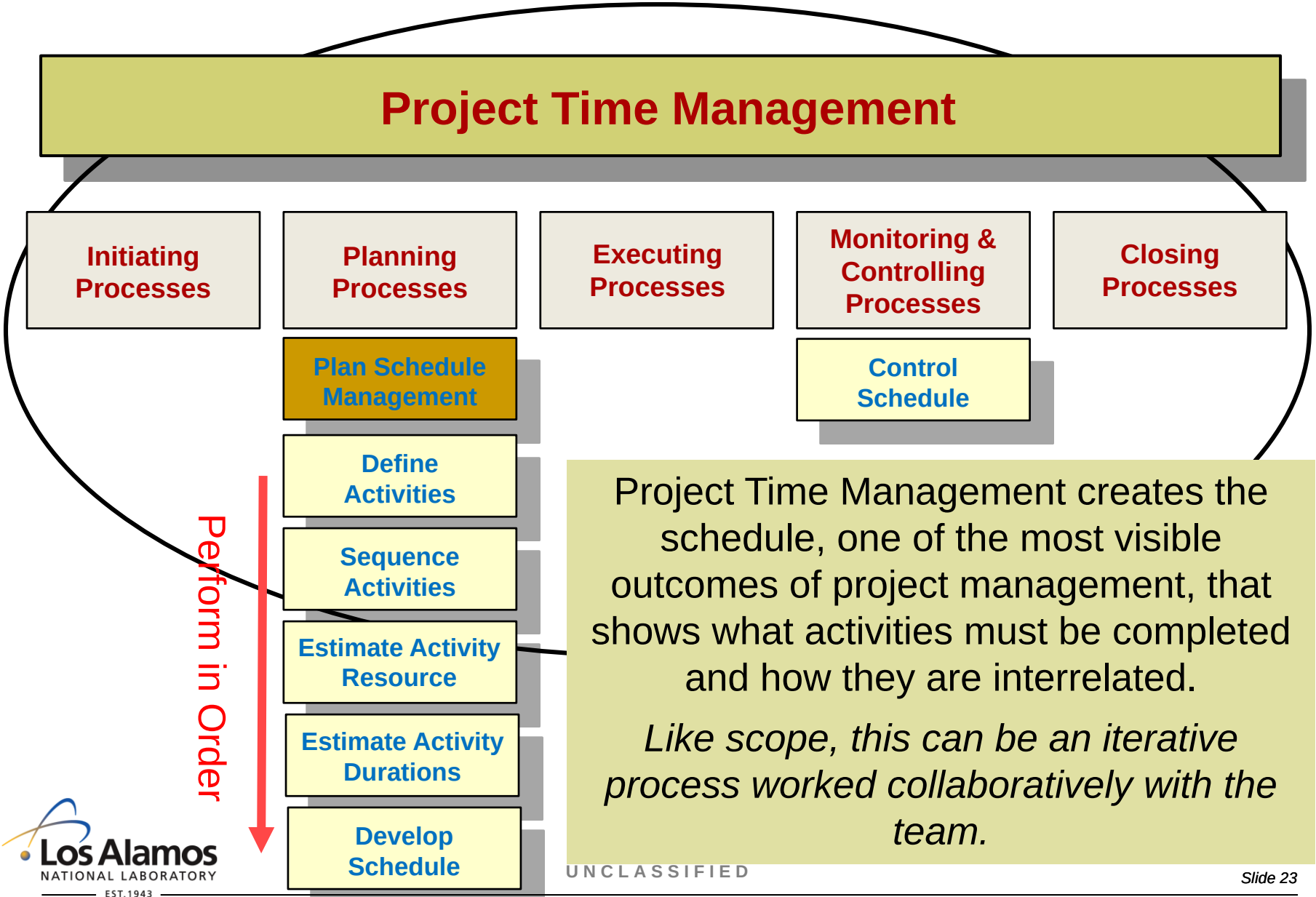
Scope definition: When is it “enough detail”?

- **Define the requirements of the deliverable in enough detail to plan, execute, control, and deliver. In other words, when …**
  - The project plan clearly describes a consistent vision to multiple stakeholders
  - You and your stakeholders agree on the endpoint definition
  - The entire team can execute with confidence and collaborate effectively
  - You, your stakeholders, and the team can understand (control) how the project is proceeding
- **This is often an iterative process between the project team and the project’s stakeholders**

Projects are doomed to failure when the scope is not properly described/understood at the beginning



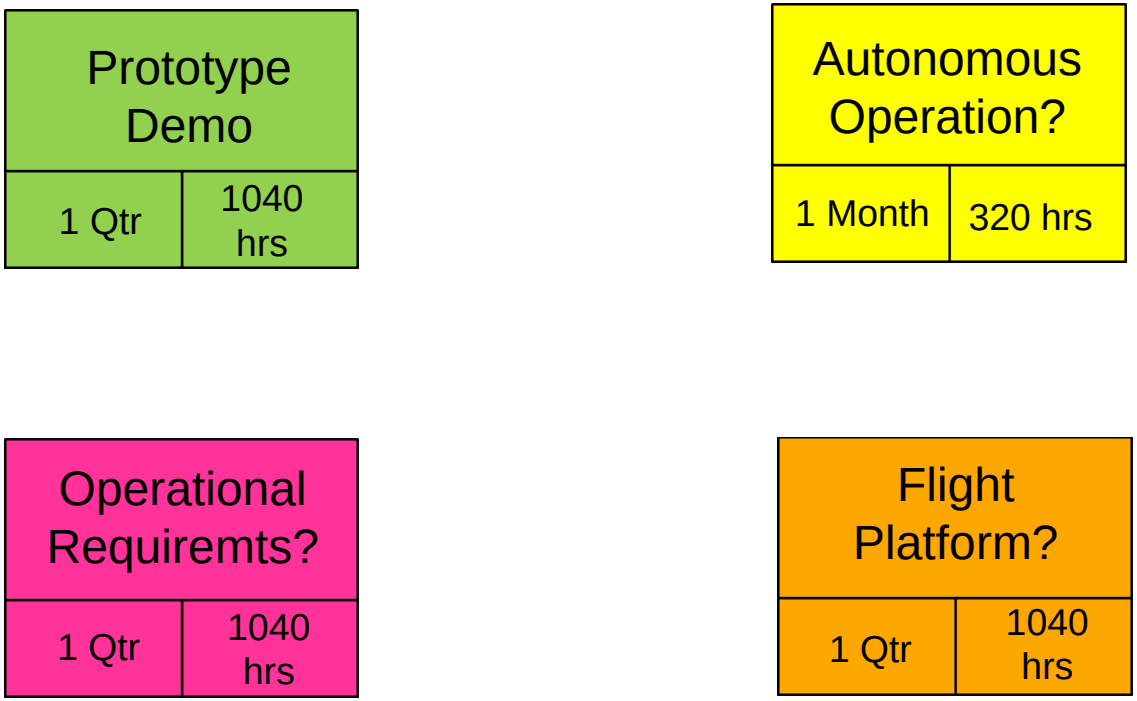
Knowledge Area 3:



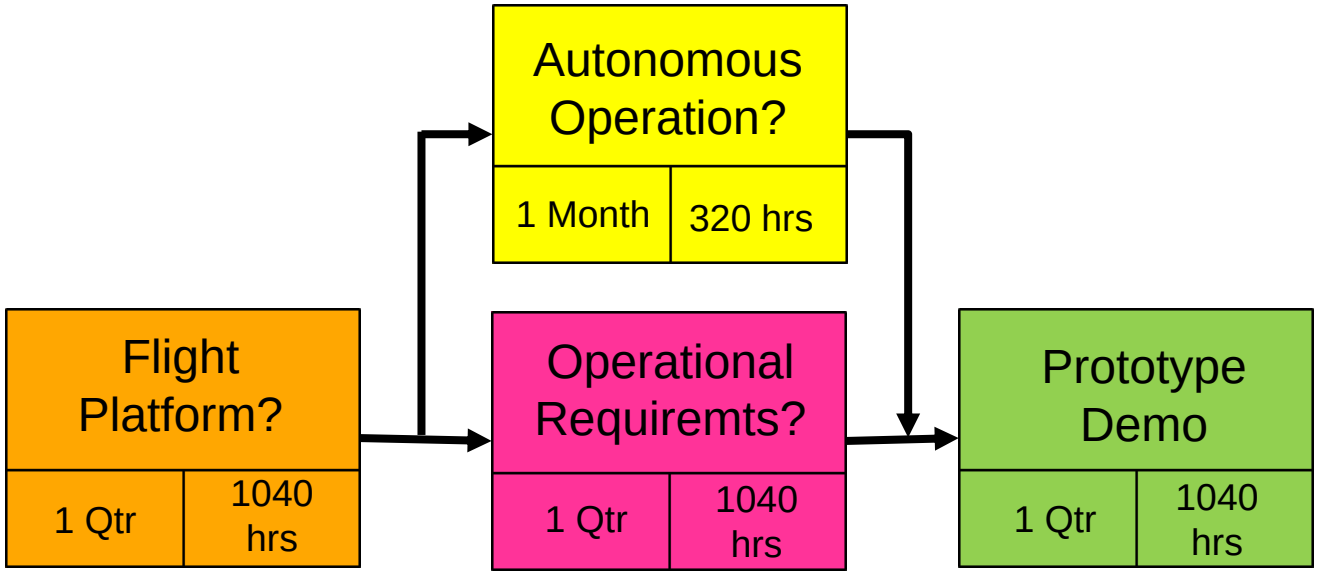
Project Time Management creates the schedule, one of the most visible outcomes of project management, that shows what activities must be completed and how they are interrelated.

Like scope, this can be an iterative process worked collaboratively with the team.

Activity sequencing demonstration



PERT diagram: Your project on Post-Its



- Graphic representation of your project schedule. Called Program Evaluation Review Technique (PERT) or network diagram.
- The high-level R&D questions often become the boxes in the PERT diagram.
- You can include due dates along with duration and total hours on the bottom half of the square.

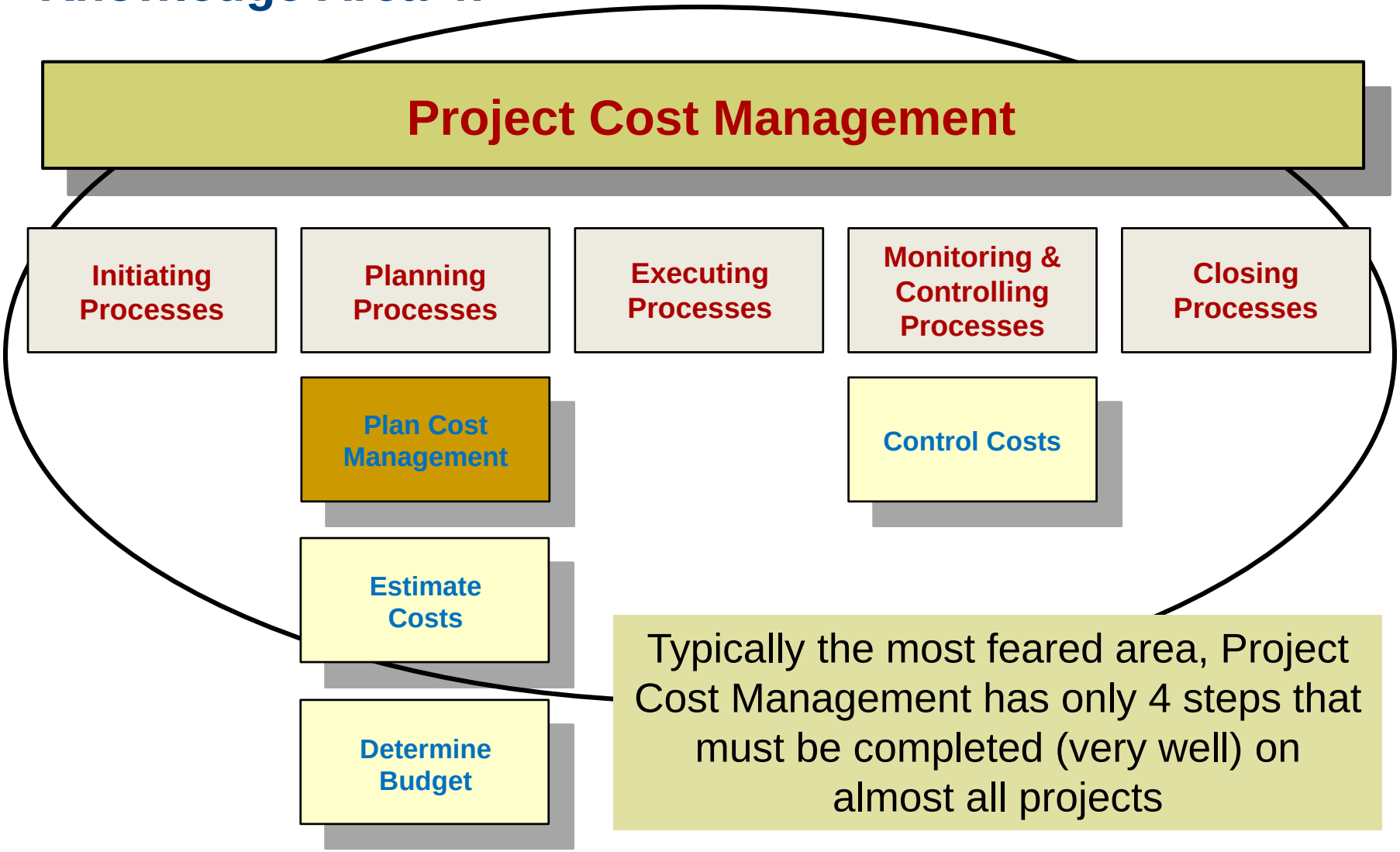
Gantt chart: A more detailed schedule

Lead	Thrust/Gateway Question Area	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
M Mouse	**Thrust 1: Flight Platform?**									
M Mouse	Aerodynamics	360								
D Duck	Materials		340	340						
P Pig	**Thrust 2: Autonomous Operation?**				320					
W Coyote	**Thrust 3: Operational Requirements?**									
F Leghorn	Computation and Data Mgmt				180					
W Coyote	Security and Custody					180				
R Runner	System Maintenance				220	220	240			
M Mouse	**Thrust 4: Prototype demo**							360	340	340

- **Schedule (or Gantt chart) is derived from the PERT diagram**
  - The template provided by the Science Resource Office includes a blank schedule
- **Most projects won't need more than a PERT Diagram**
  - Describes project scope, activities, sequence, and their relationships
  - Can easily show costs/resources
  - Dates on a PERT diagram are as good as on a schedule

Breakout Session: Build a PERT Diagram for your gateway question and related tasks. (7 min)

Knowledge Area 4:



Typically the most feared area, Project Cost Management has only 4 steps that must be completed (very well) on almost all projects

Estimate, budget and funding: A critical distinction

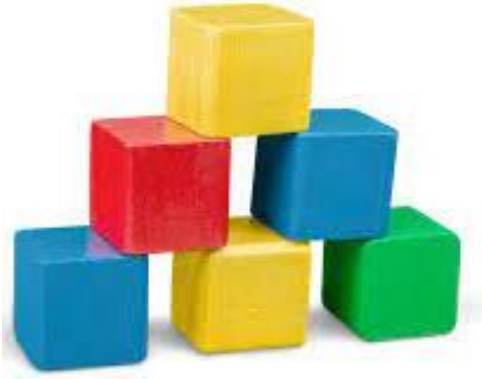
Estimate → Budget

Estimate = The individual building blocks, created by costing the components of work (material, labor)

Budget = The entire structure made up of the blocks, the total estimated cost to deliver the scope of work

VS

Funding



The amount of money you receive from your sponsors

Estimate each activity in the PERT diagram or schedule

Objective/Question Area	Estimated Cost
Thrust 1: Flight Platform?	**$150k**
Aerodynamics	$50k
Materials	$100k
Thrust 2: Autonomous Flight?	**$80k**
Thrust 3: Operational Requiremts?	**$170k**
Computation and Data Mgmt	$70k
Security and Custody	$50k
System Maintenance	$50k
Thrust 4: Prototype Demo	**$300k**

Budget: $700k

- **Include labor, procurements, closeout costs, and some contingency funds**
- **Get time and cost estimates from support organizations**
- **Unburdened or burdened?**

TOOL: Price and Estimating Module (PEM) in Oracle – estimates always based on most current labor rates and burdens

Estimating costs at LANL is very complicated. Do not do this by yourself!

Architecture behind LANL cost codes

Oracle Cost String: YYYYYA-XXXX00-ZZZZ-WWWW

- CC: Cost Center (Org Code)
- PC: Project Code (Program Code)
- CA: Cost Account (Task)
- WP: Work Package (Task)

- **Cost Center: Aligns to who is spending the money**
- **Project Code: Aligns to project or to the larger program that owns the project**
- **Cost Account and Work Package are available to track costs consistent with the project's (program's) Work Breakdown Structure or QBPM Gateway Questions**
  - Note: Tracking costs at levels below the gateway questions may cause issues if those tasks/questions change during the project.

Earned value management (EVM): How well is your project REALLY doing?

Thrust 1: Flight Platform – Budget vs. Actual Cost

	Month 1	Month 2	Month 3	Total
Planned deliverables	Aero design	Matl design	Matl test	
Budget *	$50k	$60k	$40k	$150k
Actual deliverable	Aero design		Matl design	$150k
Actual Cost	$50k	$60k	$40k	$150k
Earned Value * (based on budgeted cost)	$50k	$60k	--	$110k
Difference	$0	$0	$-40k	$-40k

Actual cost matches budget, but material tests aren't started.

Options: Ask your sponsor for more funding, or change the project scope.

* In project management parlance,
- Budget = Budgeted Cost of Work Scheduled or BCWS
- Earned Value = Budgeted Cost of Work Performed or BCWP

Project checklist

- **Use to follow along in class for the next five knowledge areas**
- **Use the checklist template to drive discussion with your R&D project teams**
- **For more complex projects: MAST questionnaire – developed by LANL management and the Naval Postgraduate School ***
- **Checklist and MAST questionnaire available on the Science Resource Office's Project Management website http://int.lanl.gov/org/ddste/sro/rdprojectmgmt/index.shtml**

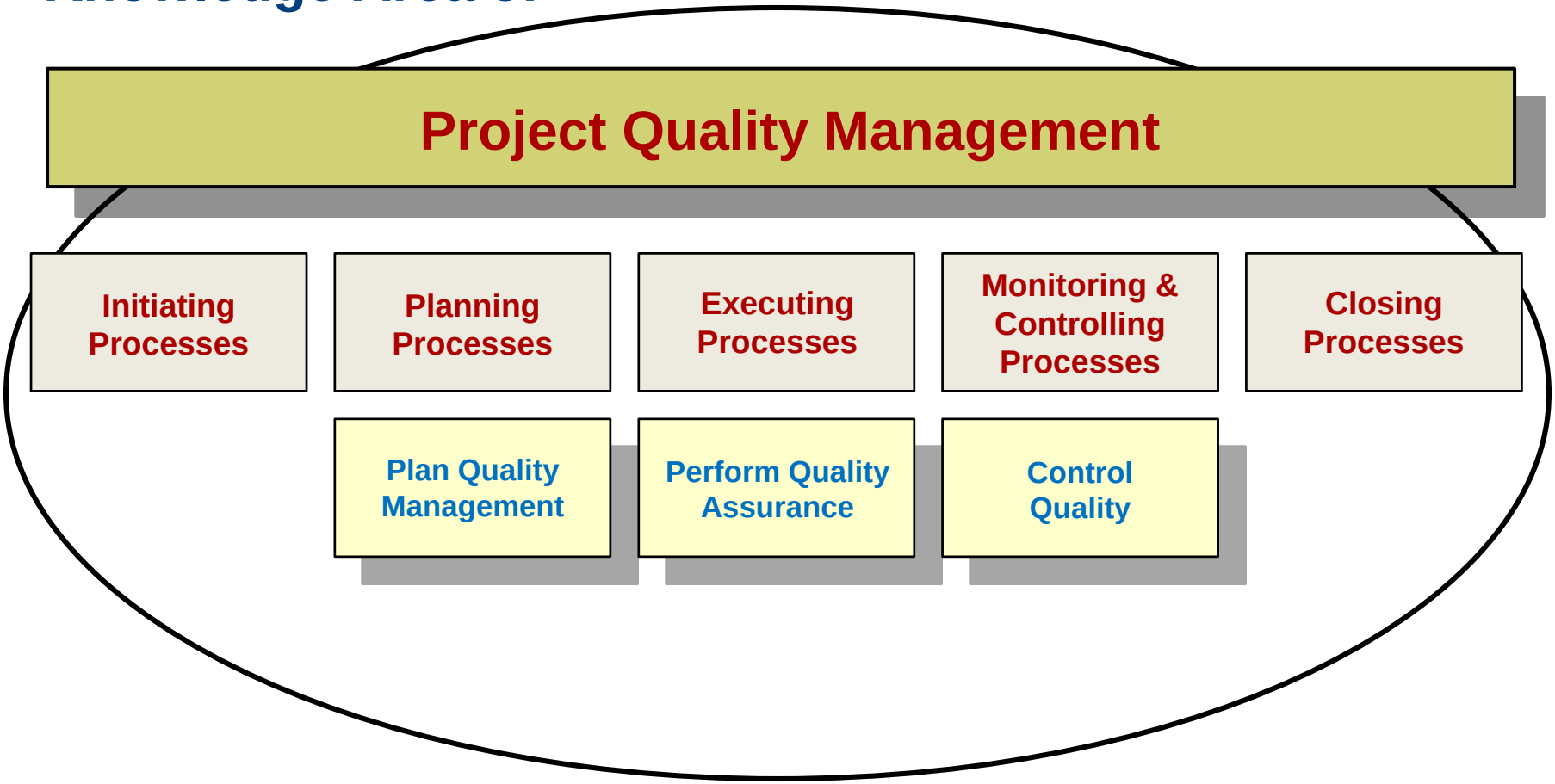
R&D Project Management Course

Project Requirements Checklist

1. **Scope** – Use the QBPM excel sheet to document the high-level R&D questions.
2. **Schedule** – Sequence questions to develop a PERT diagram and shade in the QBPM excel sheet.
3. **Quality Assurance** – What quality assurance elements will the project need to address? (E.g., project roles/responsibilities, document and records management/retention, quality requirements for procurements, user/sponsor-specific requirements and/or expectations.)
4. **Human Resources** – In addition to the team leads that you may have already identified on the Question-Based Project Management template, what other human resources (or talents/capabilities) will the project require? Consider both technical and non-technical resources.
5. **Communications** – When and how will you, your team members, sponsors, etc. communicate? What tools might you need to facilitate that communication (e.g., shared server space)?
6. **Risks** – What risks might the project encounter? How likely are they and how do you plan to respond to them?
7. **Procurements** – What procurements does the project require and how does the timing and cost fit into your project plan?

* Mission Assurance Support Tool (MAST) project headed by retired LANL Executive Advisor, Heidi Hahn

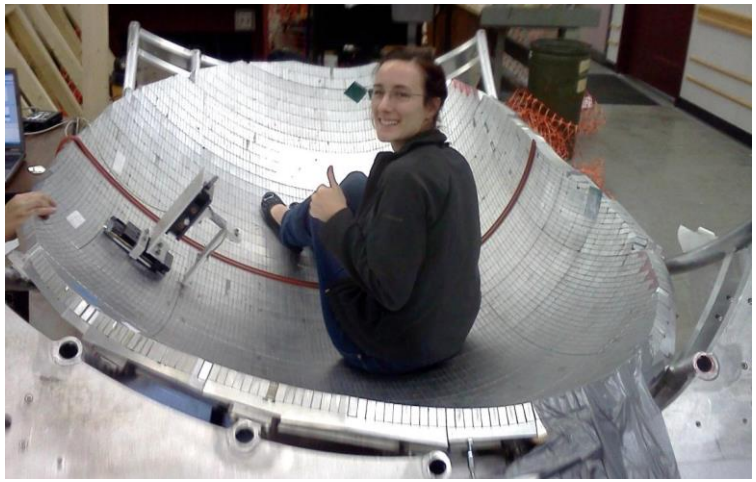
Knowledge Area 5:



Project Quality Management is often overlooked during the planning phase to the detriment of project success

Quality matters!

- **Almost all R&D projects need to address:**
  - User/sponsor-specific requirements and/or expectations
  - Quality of experimental equipment, facilities
  - Data quality (e.g., for publication), traceability and archivability
  - Replicability – quality of documentation
- **Think of QA requirements in terms of both short-term and long-term needs/benefits**
- **Know what these requirements are before execution begins**

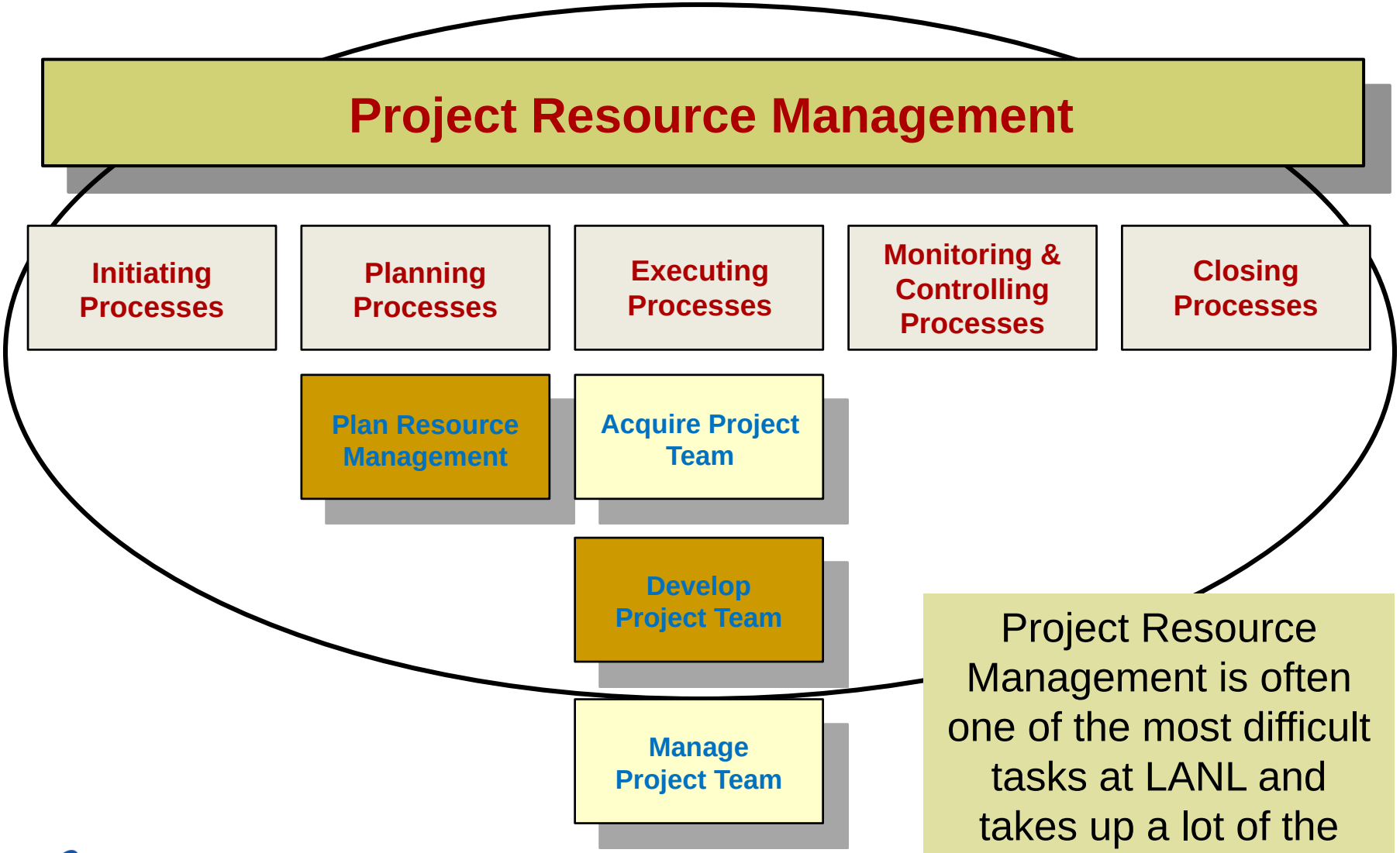


Ultracold Neutron (UCNtau) Experiment: Most precise measurement of a neutron's lifetime to date. Uses a unique, magneto-gravitational, bathtub-shaped "bottle" trap. (LANL News Story, Nov 2021.)

Undergrad Bailey Slaughter, Indiana University, maps the fields at sample locations in the trap.
Photo credit: Prof. Chen-Yu Liu of Indiana University

Question: What quality requirements might exist?

Knowledge Area 6:



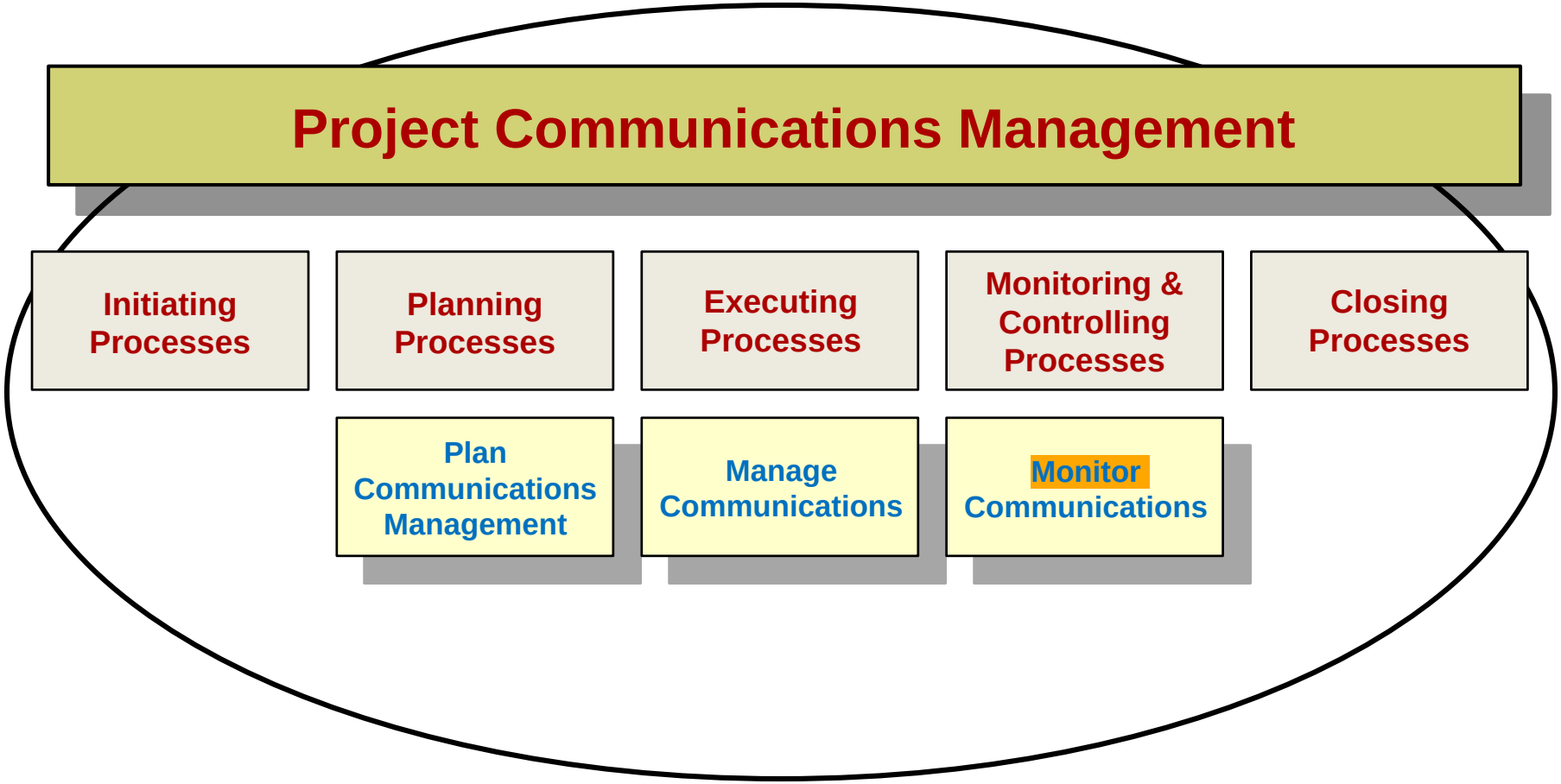
Project Resource Management is often one of the most difficult tasks at LANL and takes up a lot of the Project Manager's time

Project human resource management in a matrix organization like LANL

- **A number of decisions are necessary at the very beginning of a project**
  - What kind of talent/capability is needed on this project?
    - Technical requirements, support requirements, special requirements?
    - What are we willing to pay for this talent?
    - Is this talent available when the project needs it?
    - Can the lead assigned to the question be given full scientific authority?
  - Where are the team members located and how will I manage that?
    - Do we need team meetings, emails, websites, conference calls?
    - How big will the team get, how long will they be part of the team, what does the staffing curve look like?
  - Be prepared to have team members re-assigned unexpectedly

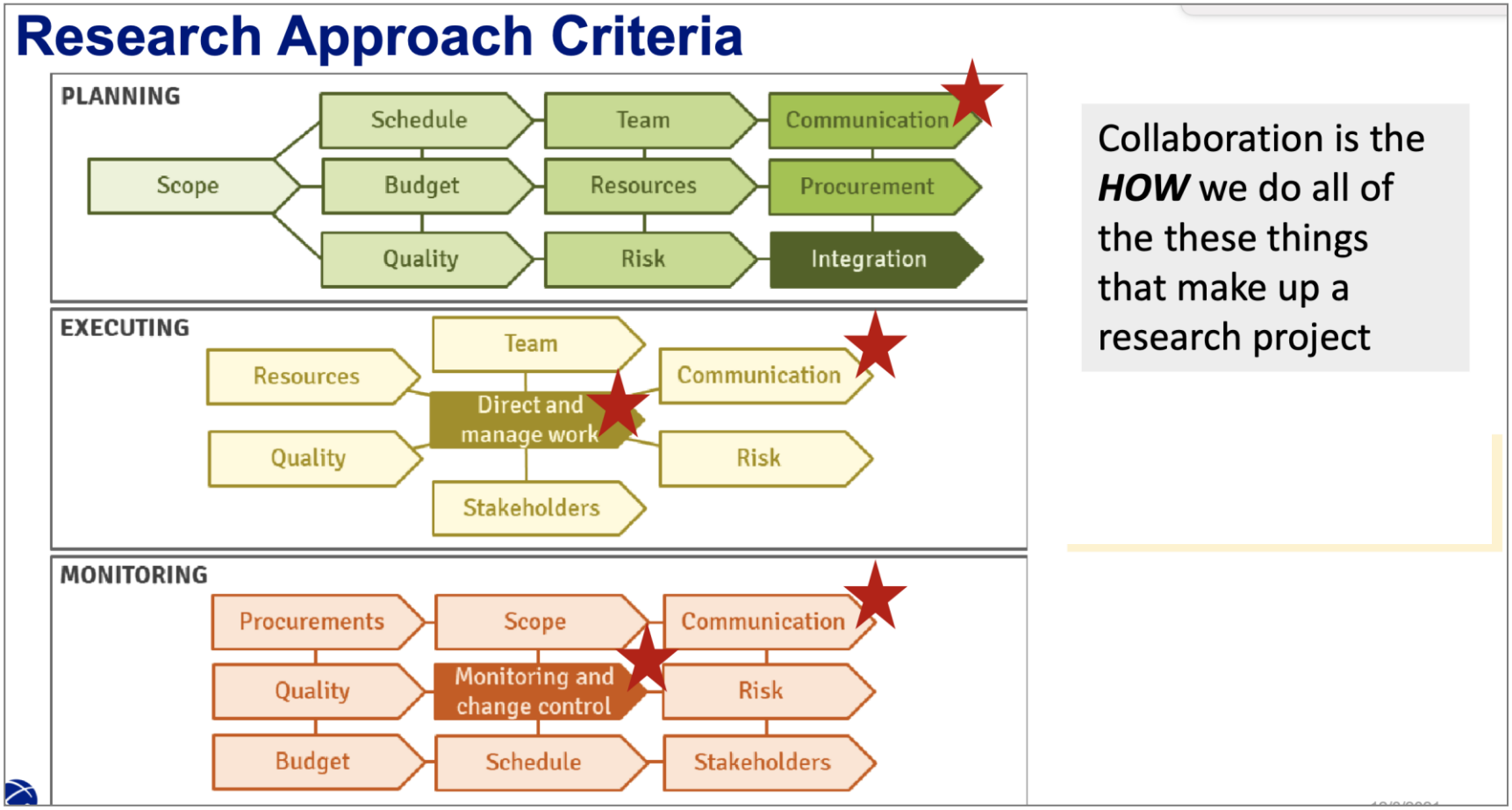
Question: What HR resources may be needed?

Knowledge Area 7:



Project Communication Management is vital throughout the life of a project. Doing this poorly will turn a successful project into a failure in the eyes of the stakeholder

Effective communication is REQUIRED in order to successfully collaborate



Source: Jeanne Fair, A proposer's guide to the "Science of Teaming," presented Dec 8, 2021 at "Getting and Staying Competitive in LDRD" event

Effective communication …

- **Requires deliberate preparation**
  - Carefully analyze your receivers
  - Listen and observe
  - Chose the right method of communication
- **Requires your initiation**
  - A message is implied even when you haven't sent one
  - Words have different meanings to different people
  - Messages don't always "soak in"
  - What is received is often different than what was sent
- **Is not simple; we've all experienced the angst of the wrong message being received.**

Too often we forget we are working with human beings

Project communication methods

- **Conference calls**
- **Project reviews with management & stakeholders**
- **Project team meetings**
- **Project scoping meetings**
- **Audits and assessments**
- **Written correspondence**
- **E-mails/shared computer space/files**
- **Metrics**

- **Frequency**
  - Daily
  - Weekly
  - Monthly
- **Formal or informal**
- **Verbal or written**
- **Limited distribution or broadcast**
- **Non-verbal**

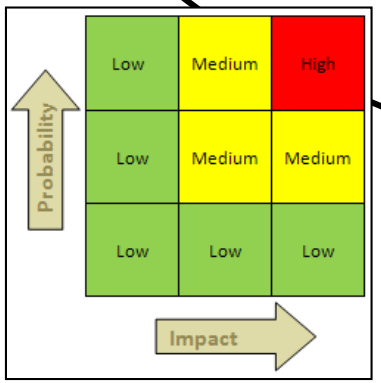
Question: What are the communication methods?

For a list of software and other tools to facilitate team communication within LANL, go to the SRO Project Management webpage at http://int.lanl.gov/org/ddste/ppo/sro/rdprojectmgmt/_assets/docs/Collaboration_Tools_and_Other_Resources.pdf

Knowledge Area 8:

Project Risk Management

Initiating Processes	Planning Processes	Executing Processes	Monitoring & Controlling Processes	Closing Processes
	Plan Risk Management		Control Risks	
	Identify Risks			
	Perform Qualitative Risk Analysis			
	Perform Quantitative Risk Analysis			
	Plan Risk Responses			



Project Risk Management is also often overlooked but is fairly easy to do, pays a great dividend, and greatly supports managing stakeholder expectations

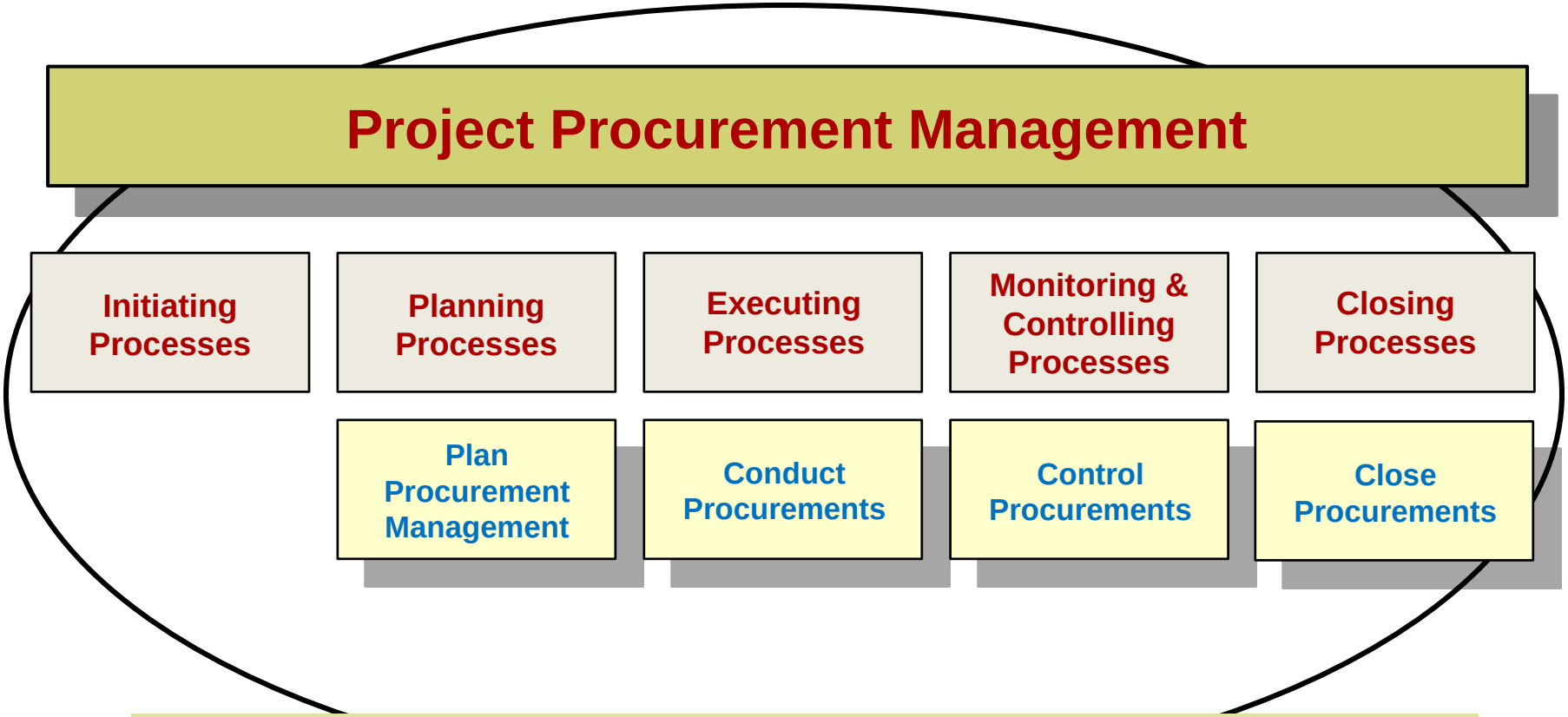
Where do risks come from?

- **Risk comes from many different areas**
  - New discovery, wrong hypothesis
  - Resources, schedule, budget, funding
    (e.g., not getting the facility time when you need it)
  - Interfaces
  - New or change in policy or regulations
  - Physical environment
  - Procurement and subcontractors
  - Safety

- **Identifying and acknowledging risks up front is critical not only to your project, but also to maintaining credibility with your stakeholders.**
- **Risk Responses: Mitigate, Transfer, Avoid and Accept**

Question: What are the risks and the risk response plan for your scope elements?

Knowledge Area 9:



Project Procurement Management is common with projects due to their temporary nature, the challenge is often integrating them within the project schedule appropriately – **They take longer and require more of your attention than you think!**

Procurement is misunderstood

- **Procurement Planning begins with understanding the project needs**
  - Subcontract for on-site services
  - University Subcontract
  - Purchase Orders
  - Pcard purchases

ONLY ASM CAN NEGOTIATE OR MAKE A COMMITMENT ON BEHALF OF THE LAB

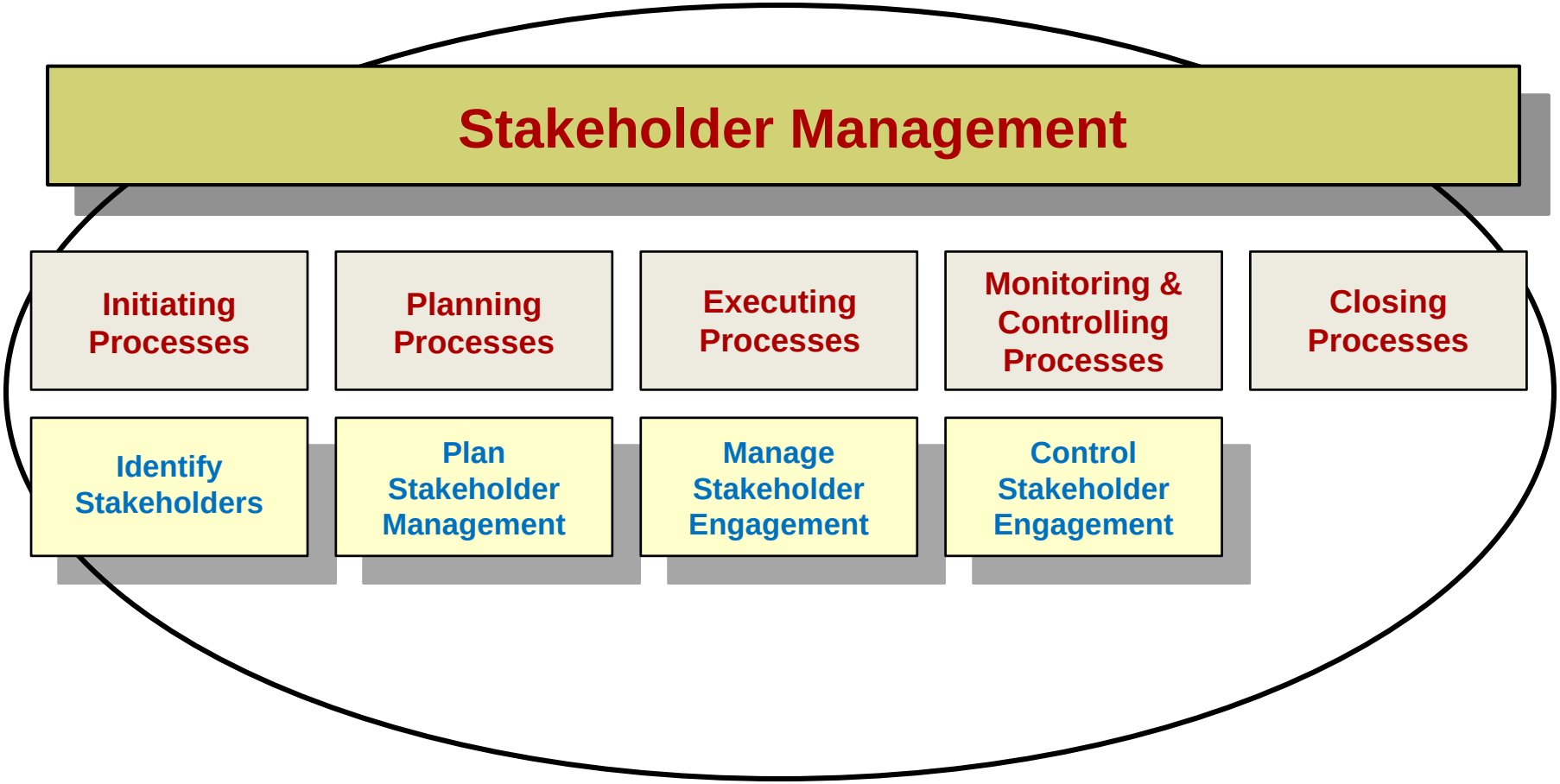
- **Start Procurement Planning Early**
  - The process is timely and involved
  - Understand special considerations such as foreign product, import/export, sole-source, QA requirements, security requirements, etc.
  - Procurement process is usually underestimated due lack of understanding
  - Approval process can vary in duration based on subcontract value
- **Subcontracts**
  - On-site services need a subcontract with proper exhibits
  - For university subcontracts, see the University Collaboration webpage on LANL's external website or contact Carolyn Bossert, ASM-STE, cbossert@lanl.gov.

Procurement administration and closeout

- **Stay on top of the procurement process**
  - There are a lot of process steps which are opportunities for it to get held-up and lose priority
- **Manage the subcontract proactively**
  - Document changes and get them negotiated quickly
  - Know where the leverage points are at all times; for the subcontractor and for you
  - Know the details of the contract, your subcontractor does
  - Make sure billing is timely and accurate; review and approve them for payment promptly
  - Make sure accruals are accurately entered into Oracle (and your earned value management system).
  - Communicate, communicate, communicate
- **Close the contract as rapidly as possible when the work is complete**
  - Getting a call from ASM two years after the project looking for paperwork to close a contract is a bad day

Question: What procurements are needed?

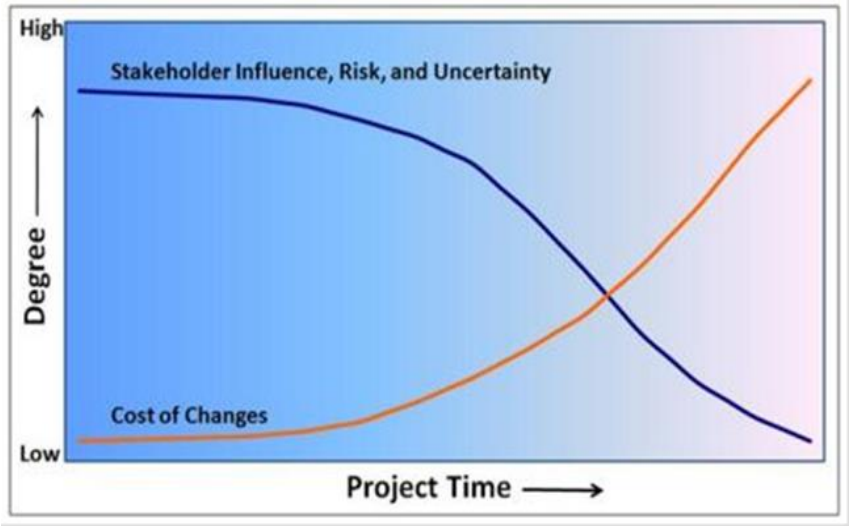
Knowledge Area 10:



Stakeholder Management is much more than meets the eye. They are constantly watching the progress and making judgments on how they are impacted.

Who are your stakeholders?

- **Customers are not your only stakeholder; it is anyone directly or indirectly involved or impacted by your project.**
- **Direct Involvement:**
  - NNSA Federal Program Manager
  - Funding Sponsor(s)
  - End User
  - Team Members
- **Indirect Involvement:**
  - Peers
  - Facility Tenants
  - Local Communities
  - State and Local Agencies

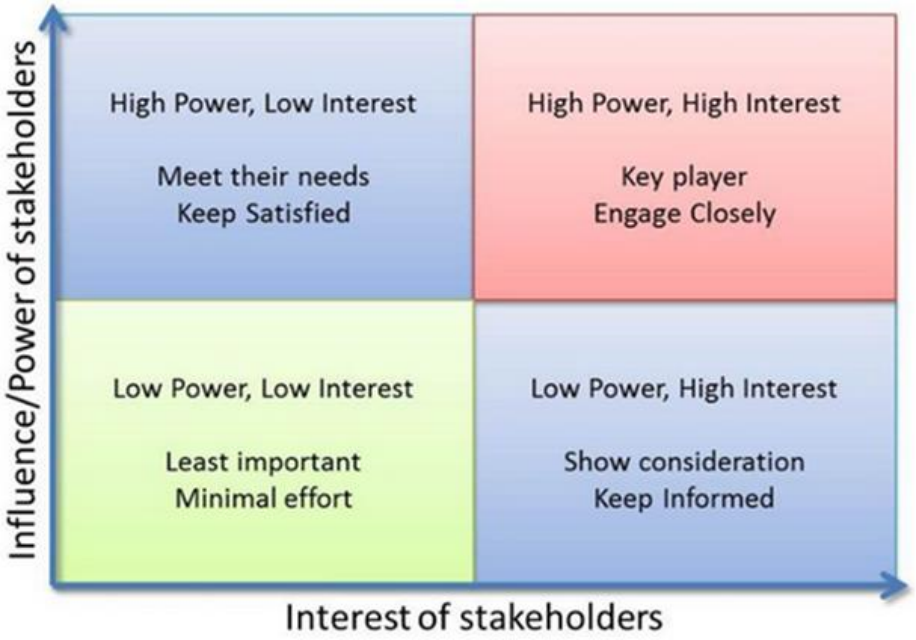


Identifying stakeholders early helps you build a healthy relationship with them upfront when they are more likely to be interested and engaged.

Question: Who are our stakeholders?

Stakeholder power and influence

- **Understanding stakeholder level power and influence on a project is essential in effectively managing stakeholders.**
- **Understand your stakeholders' key interests and communication styles, and use that information to negotiate reporting frequency, deadlines, content, and format.**

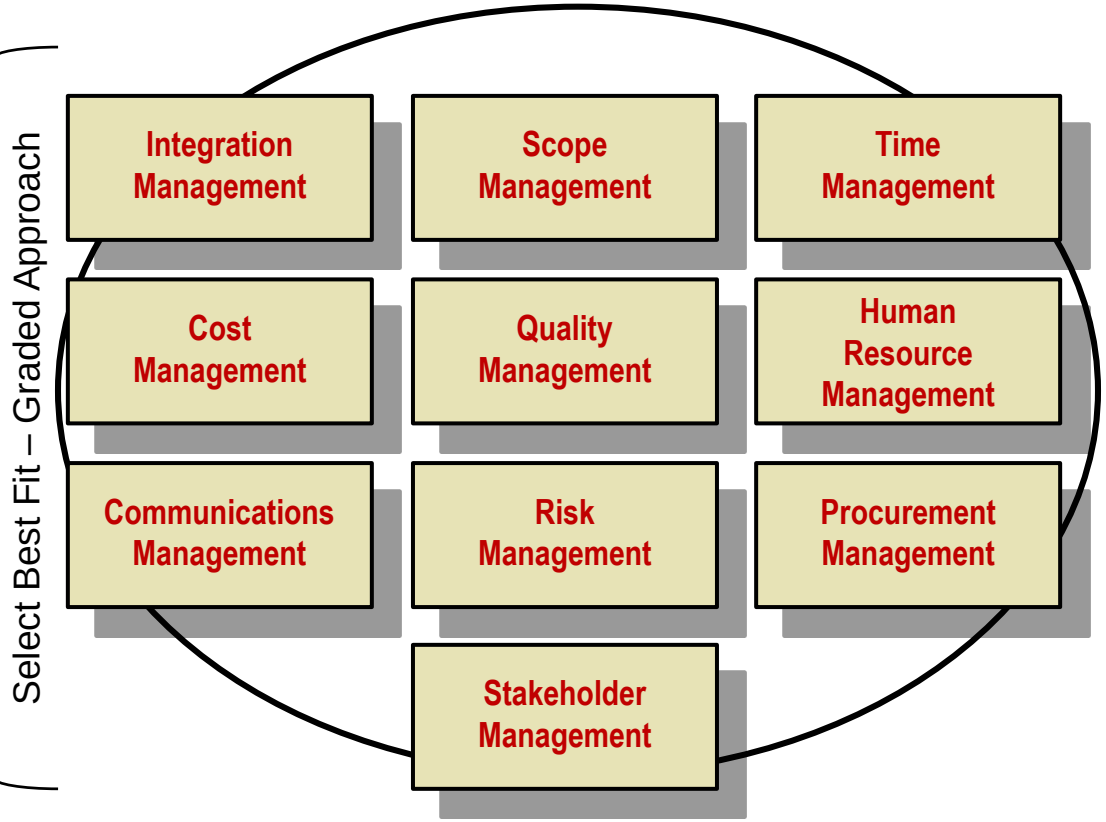


Right-size your project management needs

Some critical project characteristics include:

- Cost
- Schedule
- Number of participants
- Stakeholder
  - Involvement
  - Number
  - Interest
- Technology risks
- Consequence of failure
- Definition of failure
- Method of execution
- Experience of team

Input



Tailor to your specific project needs

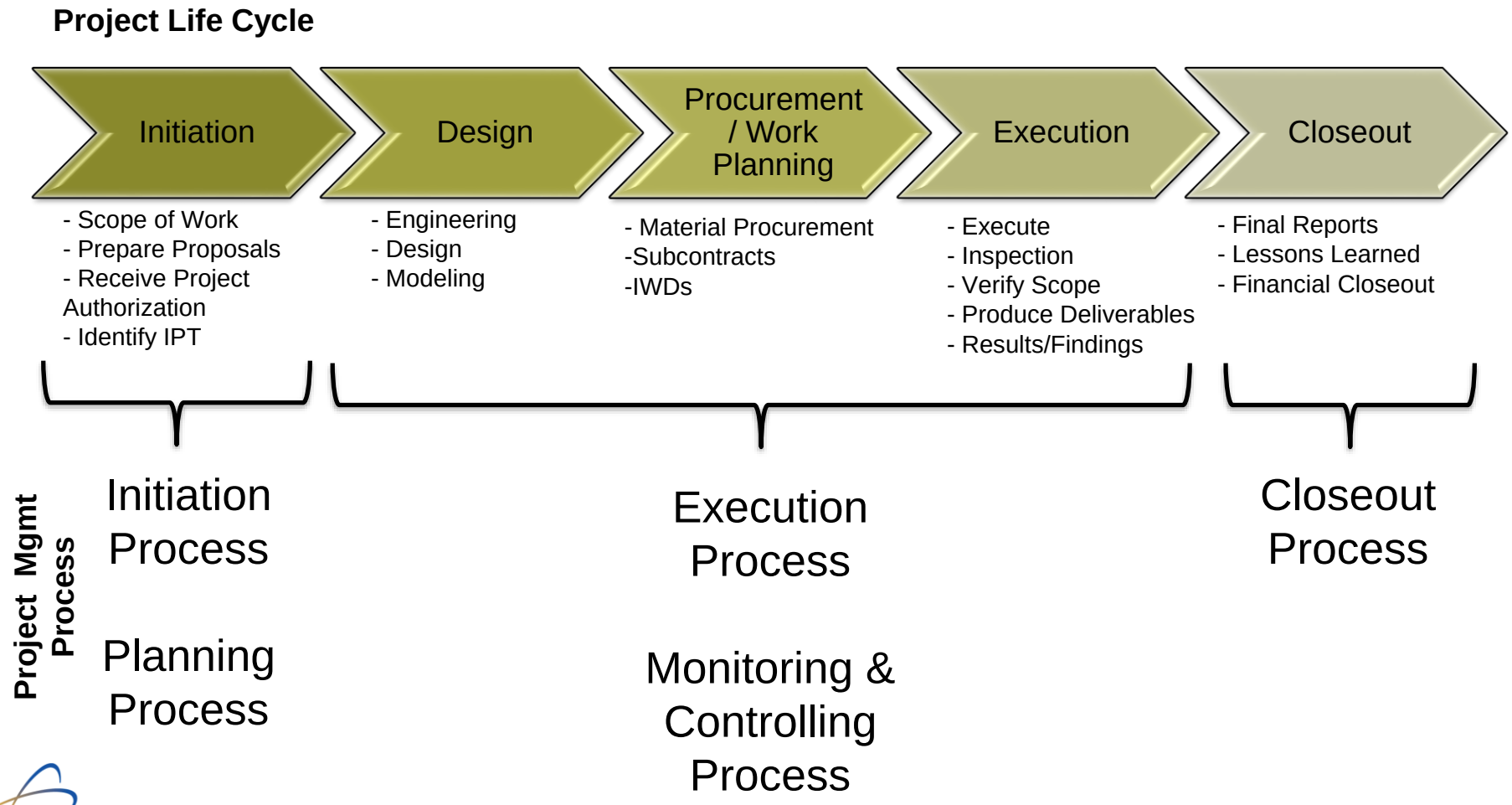
BACKUP SLIDES

For the WebEx participants

- **Instructor-led course using slides, demonstrations and in-class exercises**
- **Mute yourself either on the Webex window or your phone, not both.**
- **Use the chat to ask questions or raise your virtual hand. The instructor will answer questions at the end of each section.**
- **Use the 👍 or 👎 in the "Reactions" menu to answer instructor questions.**
- **In-class exercises will be done in Breakout Sessions**

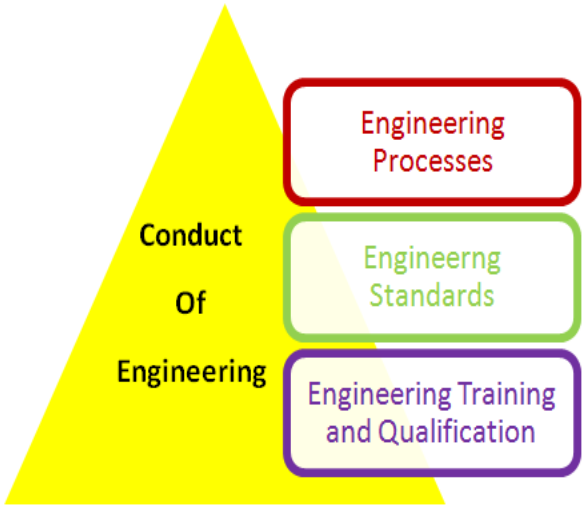
Breakout Session: Introduce yourselves to your breakout team members (Name, Org and Project Role) (7 min)

Project life cycle vs project management process



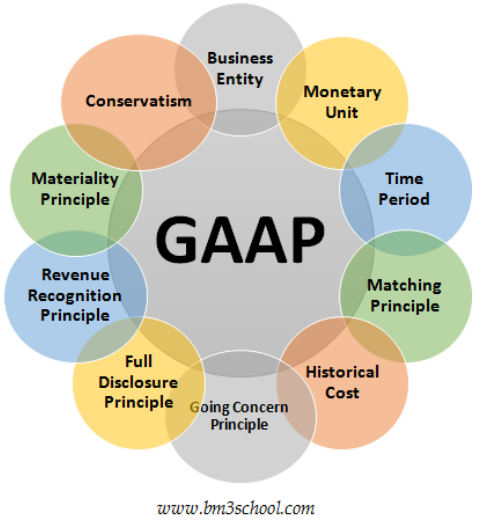
The Discipline of Project Management

Engineering
has the Conduct of
Engineering



Science
has the scientific method

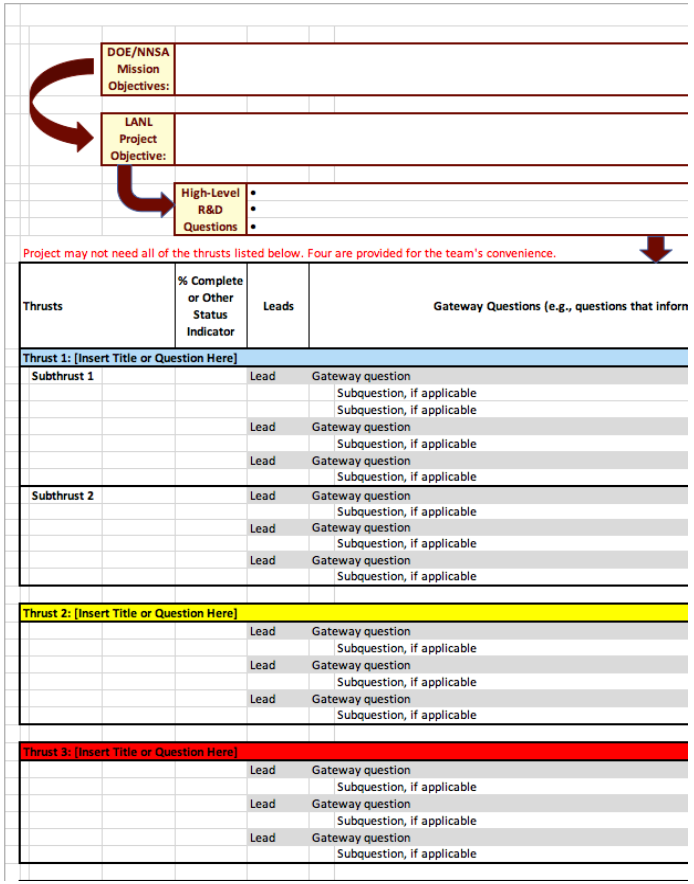
Accounting
has Generally Accepted
Accounting Principles



The discipline of Project Management is similar to these other fields of endeavor, although it is often only thought of as just a schedule and confusing cost numbers

Simple project planning checklist

- **Excel Spreadsheet**
- **Designed for R&D projects; QBPM**
- **Can be used to align stakeholders and the project team**
- **Easily completed and can be updated to reflect changes**
- **Template available on the Science Resource Office's Project Management website**
  http://int.lanl.gov/org/ddste/sro/rdprojectmgmt/index.shtml



DOE/NNSA Mission Objectives:			
LANL Project Objective:			
High-Level R&D Questions	•		
	•		
	•		

Project may not need all of the thrusts listed below. Four are provided for the team's convenience.

Thrusts	% Complete or Other Status Indicator	Leads	Gateway Questions (e.g., questions that inform
Thrust 1: [Insert Title or Question Here]			
Subthrust 1		Lead	Gateway question
			Subquestion, if applicable
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
Subthrust 2		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
Thrust 2: [Insert Title or Question Here]			
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
Thrust 3: [Insert Title or Question Here]			
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable
		Lead	Gateway question
			Subquestion, if applicable

WebEx Participants: Verify you have downloaded course materials 👍 or 👎

- See proposed alternate slide

Budget vs estimate

- **Budget: A bottom line number associated with the overall scope**
- **Estimate: Usually created by identifying the components of work (material, labor) and multiplying them by unit costs**

Budget:

- Little is known about scope
- Cost of items aren't known
- Quantity of items aren't known

Estimate:

- Scope is known to detailed level
- Individual costs are known
- Quantity of items are known

When costs start to seem high, there is little information in the budget to understand why. The estimate, however, provides enough data to see where execution has deviated from the plan

- See proposed alternate slides

End of month 4 of *Short-range Aerial Surveillance Project*

- **Monitoring and Controlling via Cash Management**
  - Total Budget: $700,000
  - Spent through Month 4 (9 Mo total): $310k (44.3% of budget, 44.4% of time)
  - Rate of Expenditure (ROE): $697.5k

Looks like it will come in under budget OR everything looks OK if the spend plan was loaded into Oracle

Let's evaluate using EVMS

- See proposed alternate slides

Monitoring costs and schedule via EVMS:

Thrust/Gateway Question Area	Month 1	Month 2	Month 3	Month 4
Thrust 1: Flight Platform?				
Aerodynamics	$50k			
Materials		$60k	$40k	
Thrust 2: Autonomous Flight?				$80k
Thrust 3: Operational Reqs?				
Computation and Data Mgmt				$20k
Security and Custody				$40k
System Maintenance				$20k
Thrust 4: Prototype Demo				

100% Complete

Not Started

Budgeted Monthly Cost	$50k	$60k	$40k	$160k
Budgeted Cost of Work Scheduled (BCWS)	$50k	$110k	$150k	$310k
Budgeted Cost of Work Performed (BCWP)	$50k	$110k	$150k	$270k
Actual Cost of Work Performed (ACWP)	$40k	$120k	$150k	$310k

- **Use schedule to identify Budgeted Cost of Work Schedule (BCWS)**
  - BCWS = $310k at ME
- **Determine % Complete by Task**
  - Ask those performing the work what percent complete is their task
    - ex: Thrust 3 activity not complete
- **Determine Budgeted Cost of Work Performed (BCWP) by Task**
  - Use the percent complete and the BUDGETED value of the work
    - ex: BCWP = $270k at ME
- **Obtain Actual Costs (AC) by Task**
  - Get the actual costs from Budget Analyst
  - Include accruals for subcontracted work, materials and equipment
    - ex: AC = $310 at ME

- See proposed alternate slides

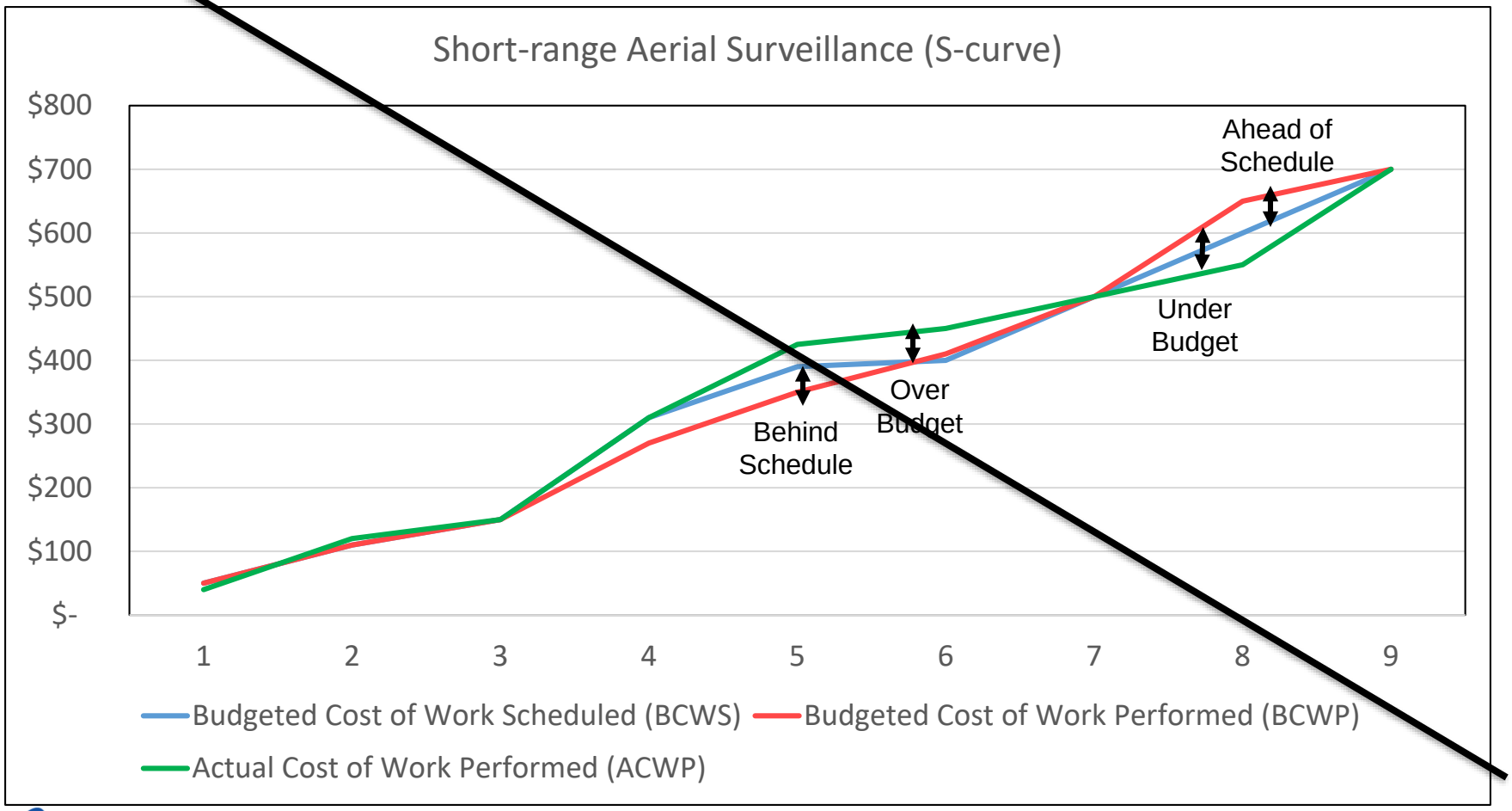
End of month 4 of *Short-range Aerial Surveillance Project*

- **Project Report (Earned Value Management):**
  - Budgeted Cost for the Work Scheduled (BCWS): $310k (from schedule)
  - Actual Cost of Work Performed (ACWP): $310k (from CFO, includes accruals)
  - **Budgeted Cost of Work Performed (BCWP): $270k (from completion estimates)**
  - Cost Variance (BCWP – ACWP): -$40k
  - Schedule Variance(BCWP – BCWS): -$40k

Project is in budget and schedule trouble!

- See proposed alternate slides

Results at the end of the *Short-range Aerial Surveillance Project*



Cost Variance = BCWP – ACWP

Schedule Variance = BCWP – BCWS